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Structural Studies of Deuterium-Helium Solids

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Results: We have used x-ray diffraction to study the structure of mesoporous deuterium-helium solids created after the injection of deuterium particles into a volume of superfluid helium. Clusters of impurities with size of the order of 5 nm and density $\sim 10^{20}$ impurities/cm³ were observed. When the samples were warmed up above the lambda point (2.2 K) and dried of surrounding liquid helium, irreversible structural changes were observed. In particular, the dry samples had significantly higher density and also larger cluster size than the as-prepared samples. In addition to being of fundamental interest, the properties of the unique porous media studied in this work may be relevant to investigations of low-temperature chemical reactions, storage of free radicals, matrix isolation spectroscopy, and superfluid helium confined in the pores of an extremely compliant medium. In particular, our results will help to explain the recent results obtained for helium-deuterium exchange reactions in hydrogen-deuterium-helium mesoporous systems.